



Estrategias de control de la lixiviación de nitratos: empleo de cultivos cubierta y NTOOLBOX

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- Empleo de cultivos cubierta en sistemas de regadío
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 - NDICEA: Modelo de simulación del balance de N en sistemas de cultivo



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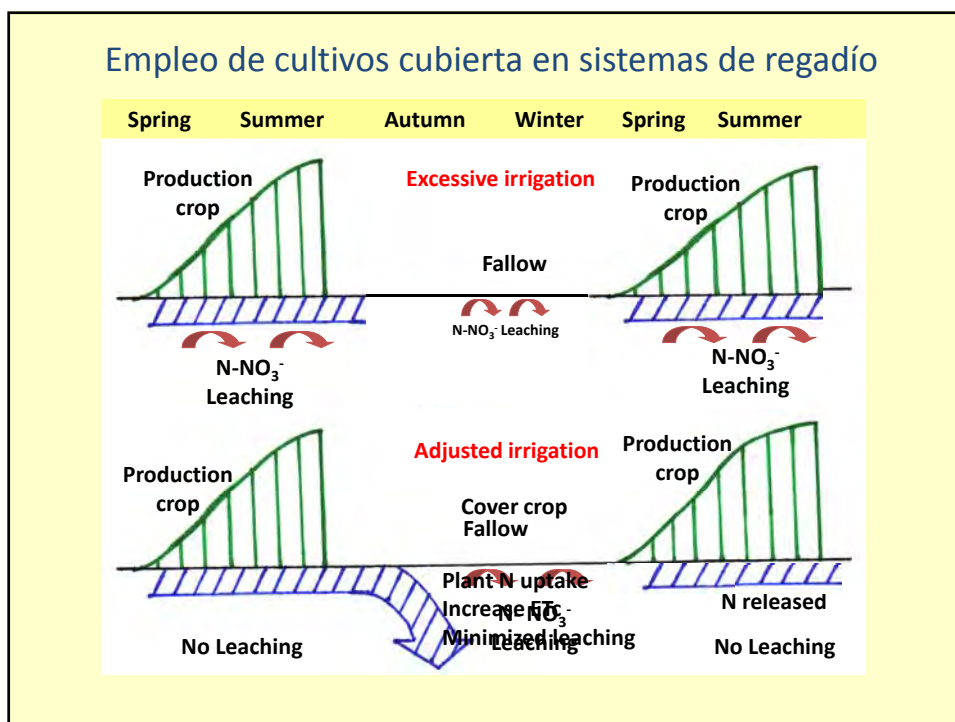
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Introduction




Cultivos cubierta

- Introducidos en sistemas de cultivo para aumentar la sostenibilidad sin buscar *a priori* un beneficio económico
- beneficios:
 - ✓ Control erosión suelo
 - ✓ Mejora calidad suelo
 - ✓ Reciclaje de nutrientes
 - ✓ Control de malas hierbas, plagas y enfermedades
 - ✓ Reducir la lixiviación de nitratos





Objetivos




Estudiar el efecto de reemplazar el barbecho con cultivos cubierta en sistema intensivos de regadío.

Nos centramos en sistemas de cultivo de maíz:

- productividad del cultivo y N absorbido por el CC y maíz
- eficiencia de uso del N y fertilizante recuperado
- acumulación de N mineral en el suelo
- balance de agua y lixiviación nitratos

Material and methods





✗ **Farm “La Chimenea”**

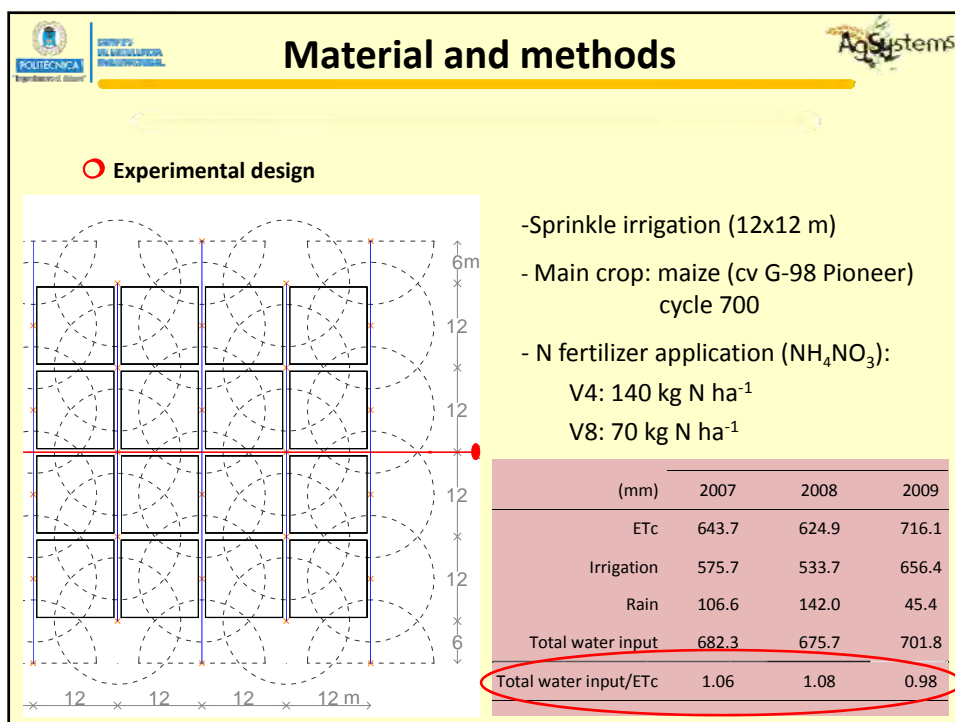
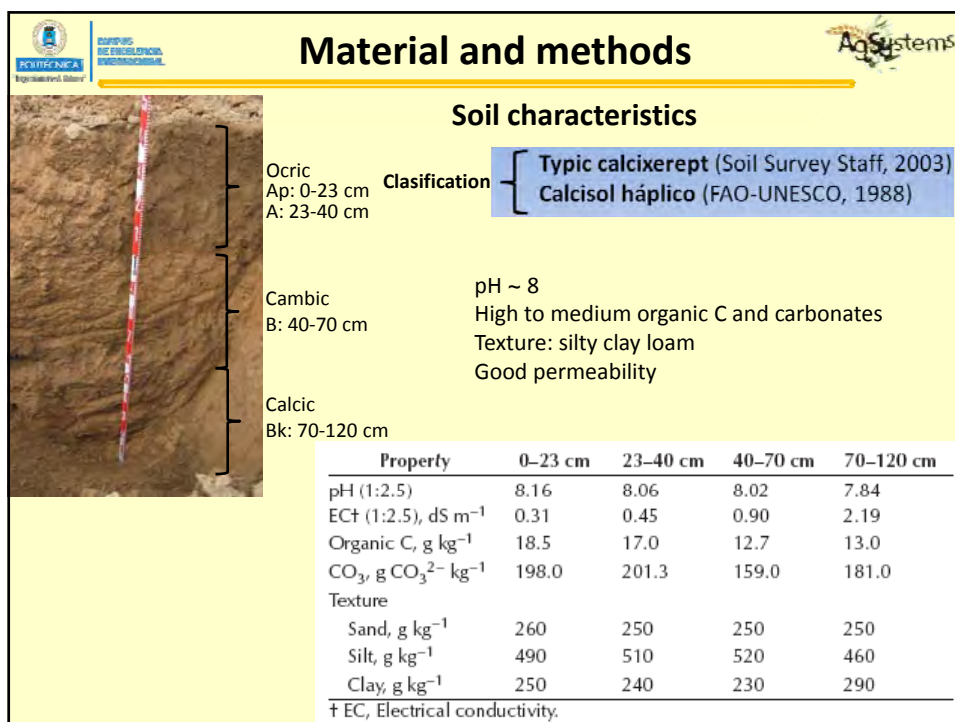
✗ **Climate:** Dry Mediterranean, monoxeric (June-Septembre)

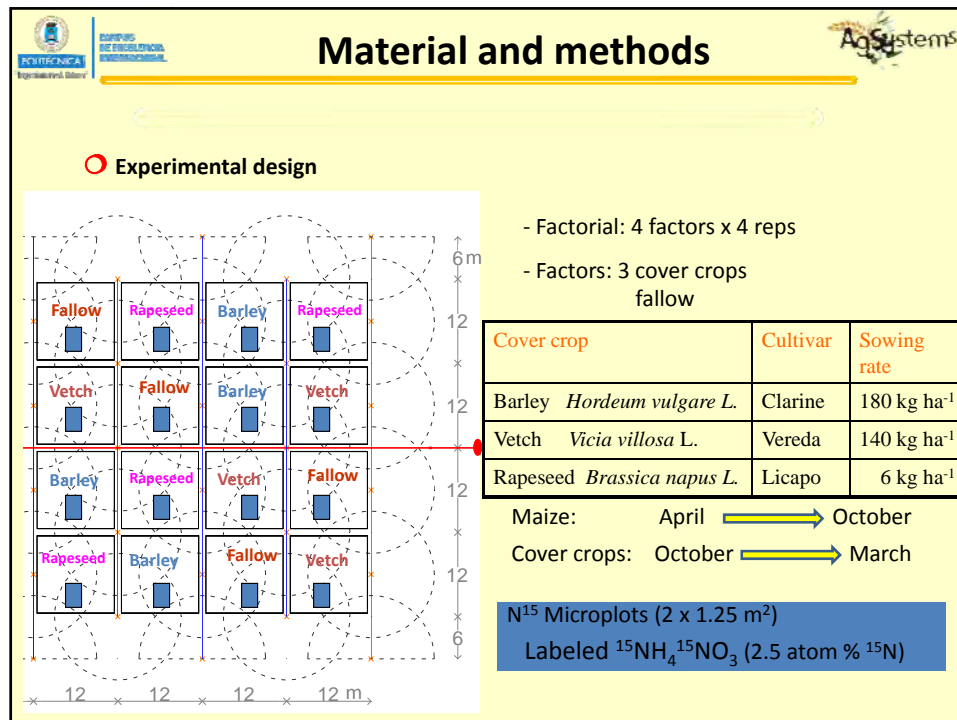
- Mean temperature: 20.5 °C, maximum 34 °C and minimum 6.5 °C
- Mean rainfall: 450 mm
- ETo=753 mm

Location: Aranjuez, Taxis river Valley

© Repsol YPF 2006, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 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Material and methods

○ Experimental procedure and measurements

2006		2007		2008		2009		2010	
Oct	Ap	Oct	Ap	Oct	Ap	Oct	Ap	Oct	Ap
Cover crops	Maize	Cover crops	Maize	Cover crops	Maize	Cover crops	Maize	Cover crops	

Soil NMIN_{1.2 m}: KCl extracts in 0.20 m intervals (NH₄⁺+NO₃⁻)

Plant biomass CC: aerial 4 x 1 m² per plot; roots in soil cores down to 0.4 m

Maize yield and biomass: central fringe of 14 m² per plot (10 x 1.4 m²)

Plant N and C concentration: dry combustion of plant components

¹⁵N by mass spectrometry: plant and soil samples from microplots

Crop N uptake = $\sum (\text{Biomass} \times \text{Plant N concentration})_{\text{components}}$

Material and methods

N¹⁵ Microplots (2 x 1.25 m²)
Labeled ¹⁵NH₄¹⁵NO₃ (2.5 atom % ¹⁵N)

Two applications: V4: 140 kg N ha⁻¹
 V8: 70 kg N ha⁻¹

Year 2


Year 1

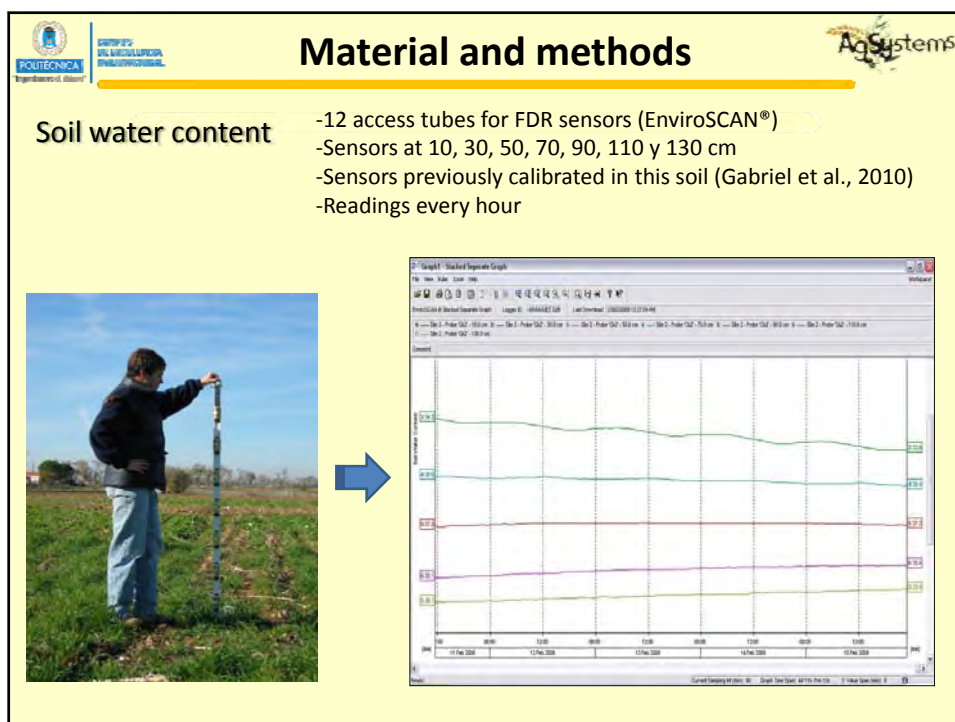
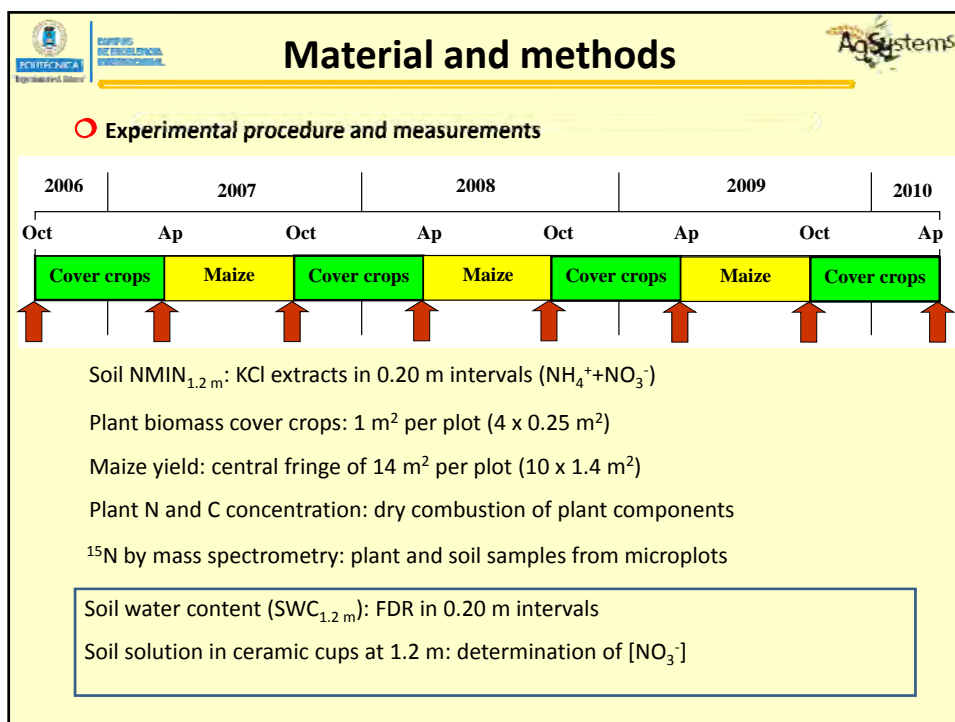
Year 3

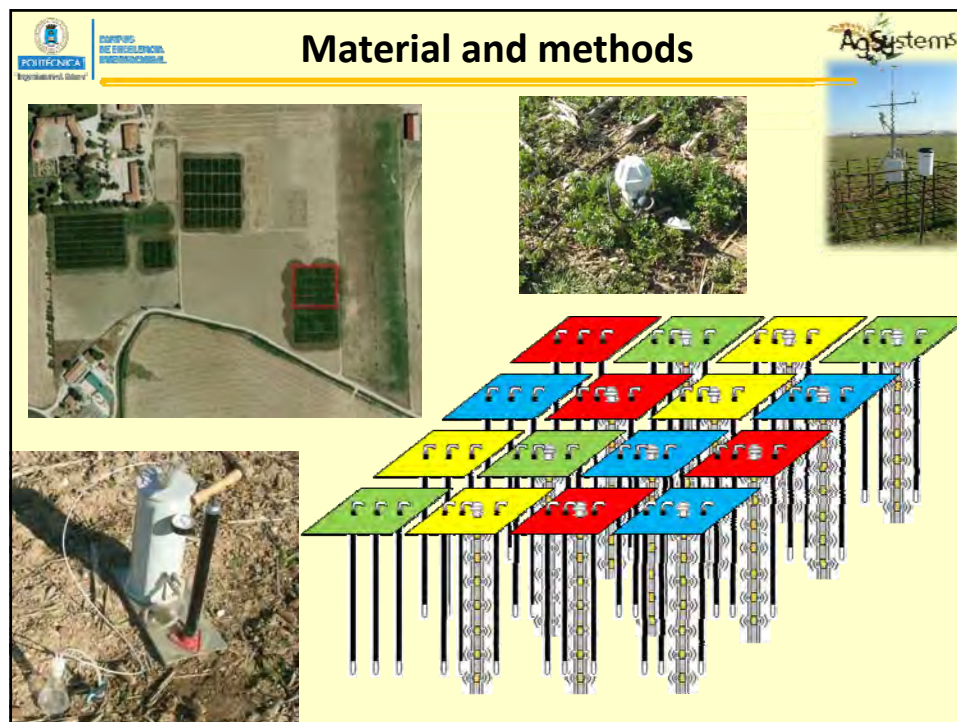
$$\text{Crop } ^{15}\text{N recovery } (^{15}\text{N}_R) = N_{\text{uptake}} \frac{\{[^{15}\text{N}_{\text{plant}}] - [^{15}\text{N}_{\text{nat. ab.}}]\}}{\{[^{15}\text{N}_{\text{fert}}] - [^{15}\text{N}_{\text{nat. ab.}}]\}}$$

N fertilizer efficiency (NRF) = $100 \frac{^{15}\text{N}_R}{^{15}\text{N}_{\text{fert}}}$

N from other sources (NOS) = $\text{Crop } N_{\text{uptake}} - ^{15}\text{N}_R$

$$\text{Soil } ^{15}\text{N recovered} = N_{\text{soil}} \frac{\{[^{15}\text{N}_{\text{soil}}] - [^{15}\text{N}_{\text{nat. ab.}}]\}}{\{[^{15}\text{N}_{\text{fert}}] - [^{15}\text{N}_{\text{nat. ab.}}]\}}$$






Material and methods

○ Calculations

- **Water balance** : obtained by inverse calibration of the numerical model WAVE (Vanclooster et al. 1996) with soil water data collected daily with FDR sensors.

Outputs: Crop evapotranspiration (ETc)
 Water percolation below root zone (= Drainage)
 Runoff (negligible)

- **Nitrate leaching**:


soil solution sampling intervals: $N-NO_3^- \text{ leached} = \text{Drainage} \times [N-NO_3^-]_{\text{soil solution 1.3 m}}$

Cumulative nitrate leaching = $\sum (\text{nitrate leaching intervals})$

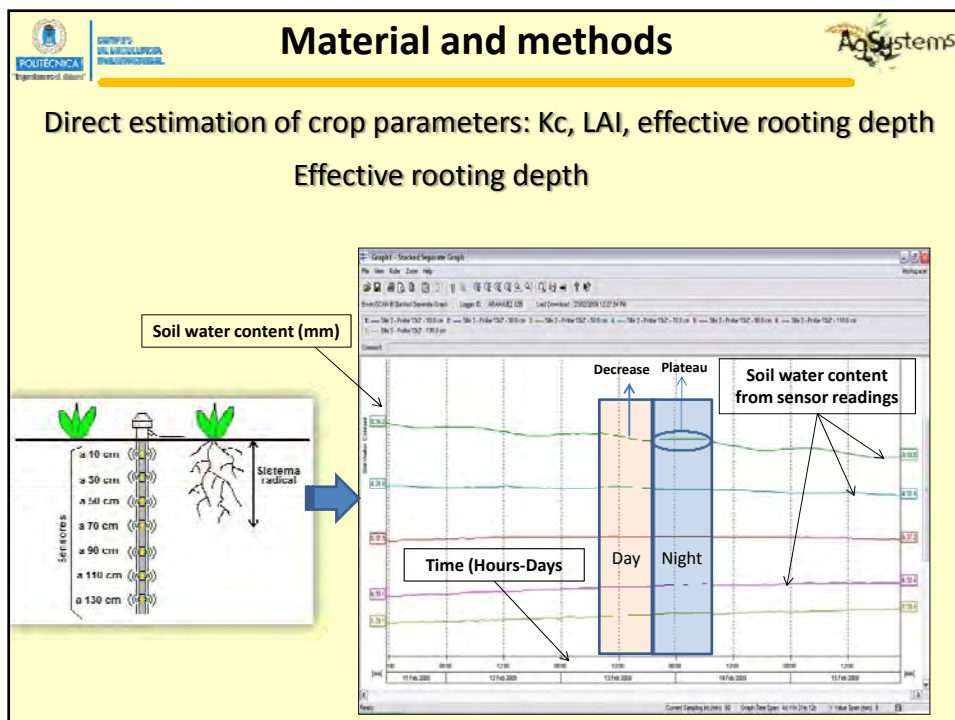
Material and methods


Direct estimation of crop parameters: K_c , LAI, effective rooting depth
Monitoring of ground cover (GC) base on digital image analysis

GC → K_c FAO method (Allen et al., 1998)
GC → LAI estimated by (Ramírez et al., 2012)




- Four images of 1 m² per plot
- Every other week







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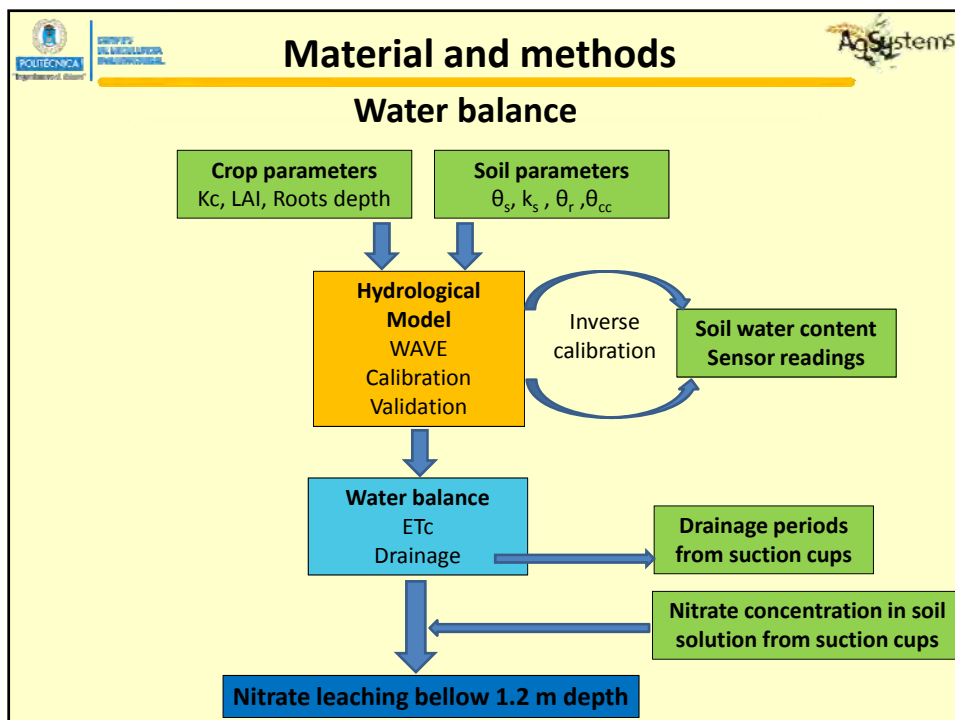
Material and methods




Direct estimation of soil parameters

- Bulk density (estimation of soil saturation water content θ_s)
- Hydraulic conductivity (k_s) in disturbed soil samples
- Residual soil water content (θ_r) from sensor readings
- Soil water content at field capacity (θ_{cc}) from sensor readings


➔







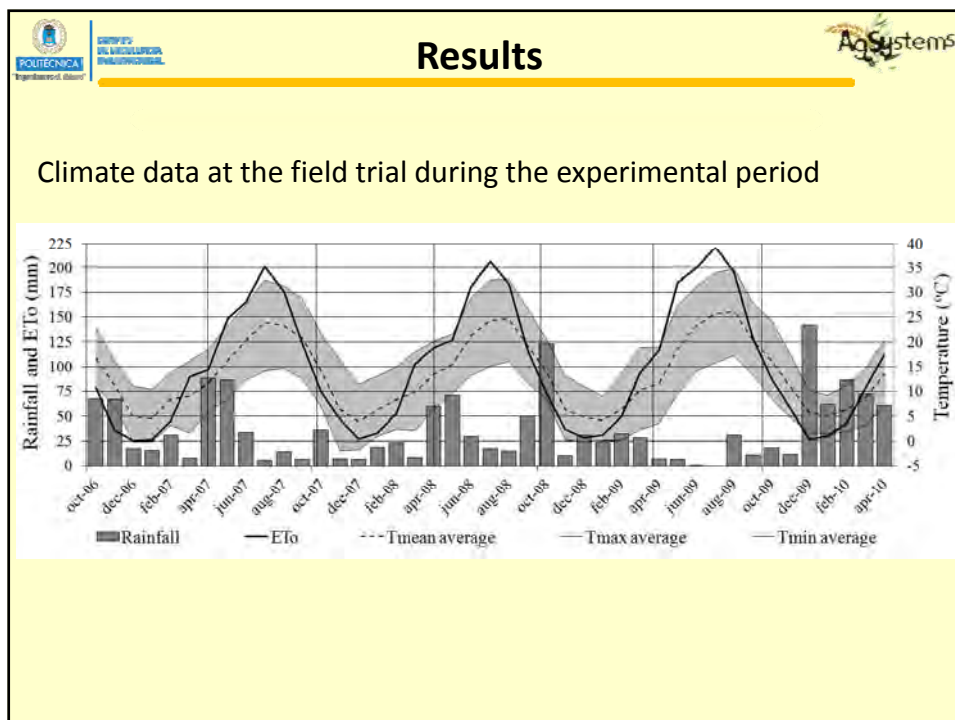
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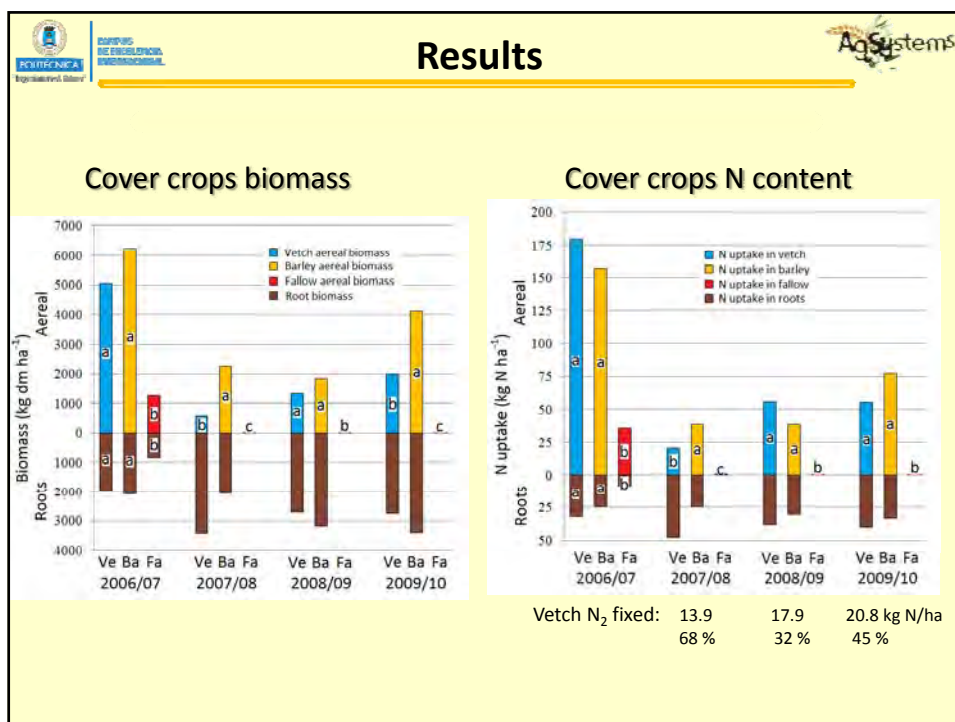
Department of Agricultural Engineering

Results



- crop productivity and N uptake by CC and maize
- N fertilizer efficiency and recovery
- accumulation of soil mineral N



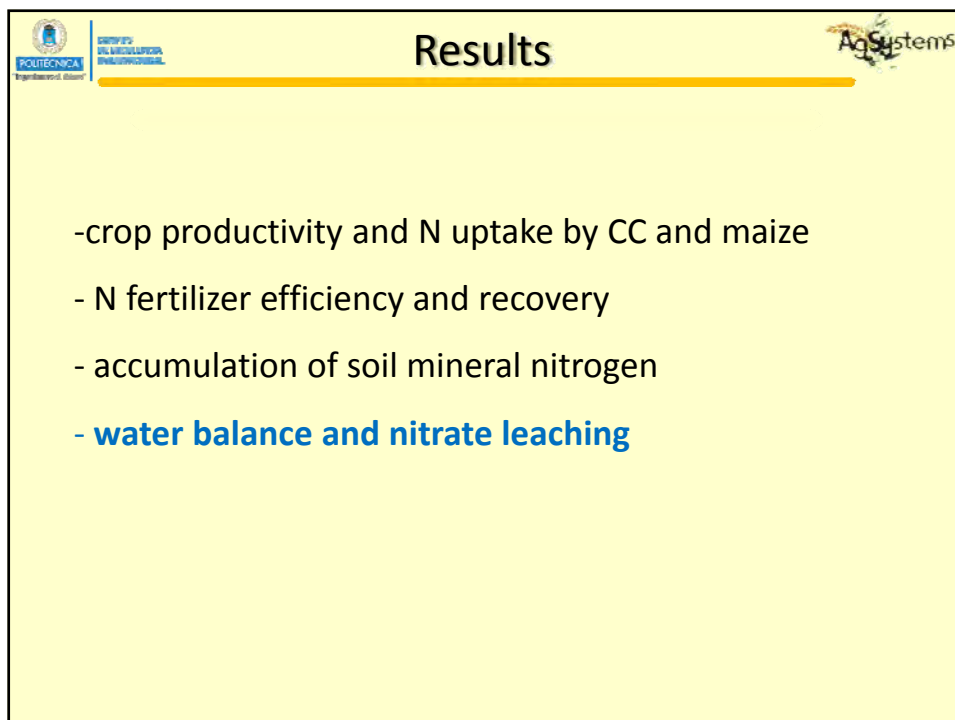
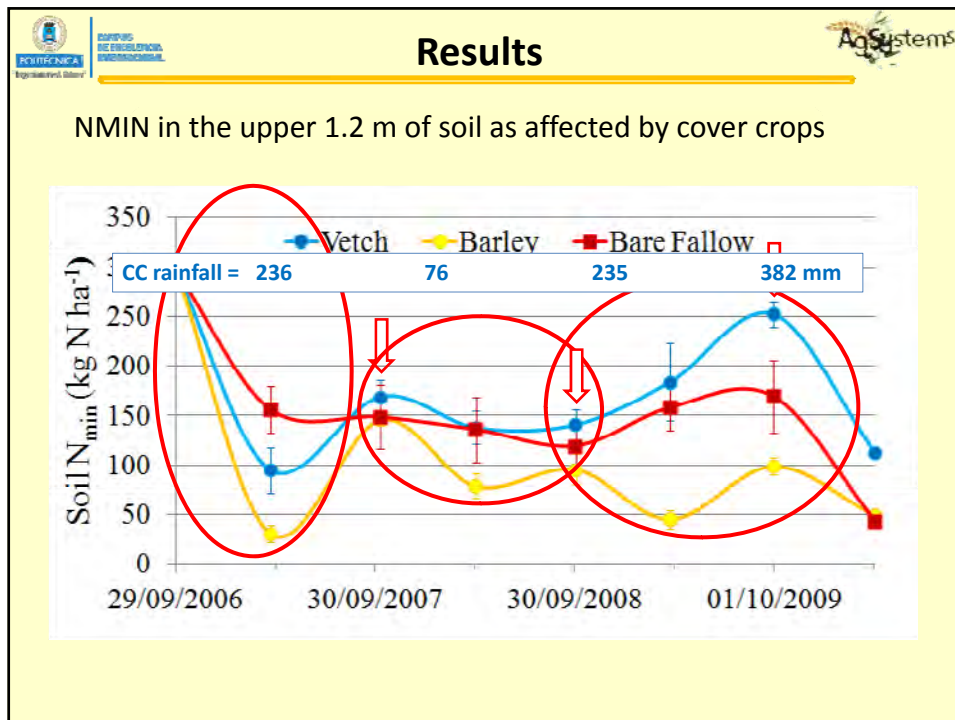


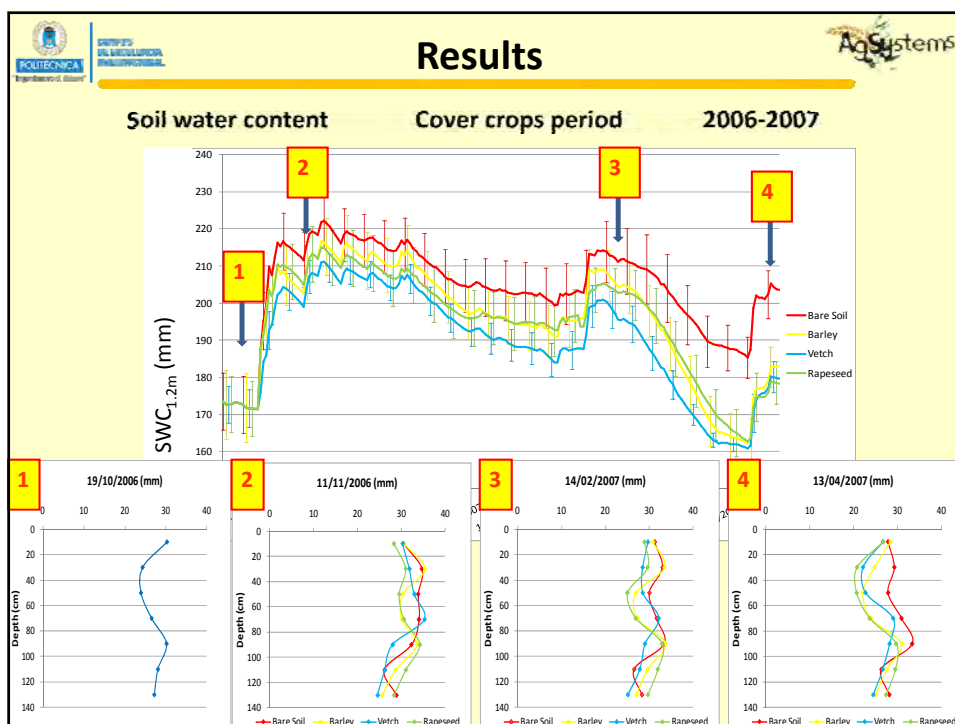
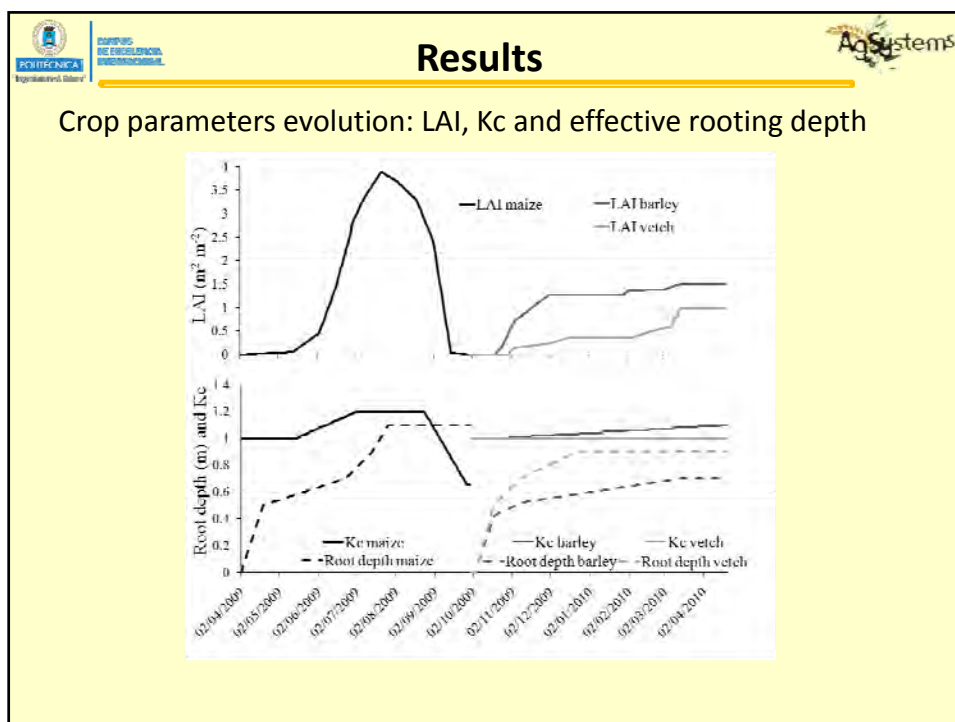
Results

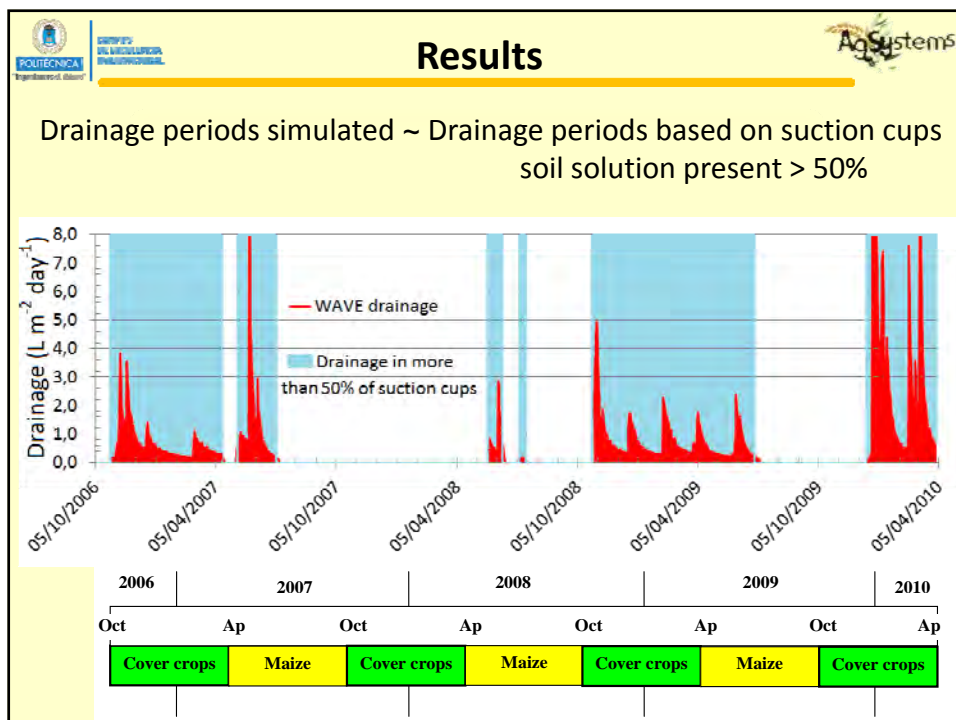
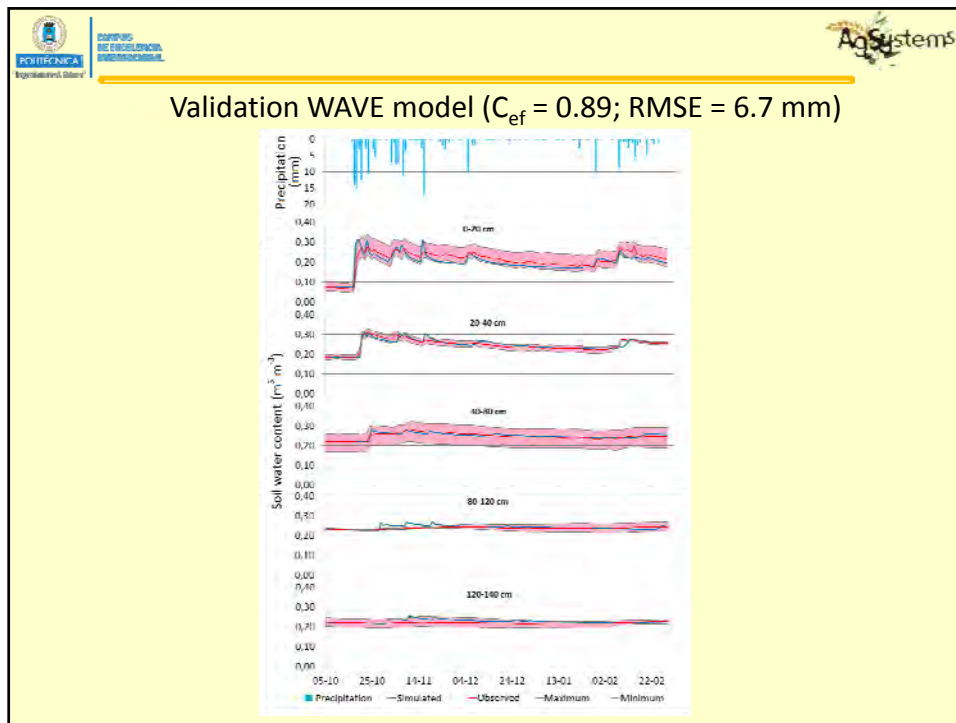
Maize biomass, yield and N content as affected by cover crops

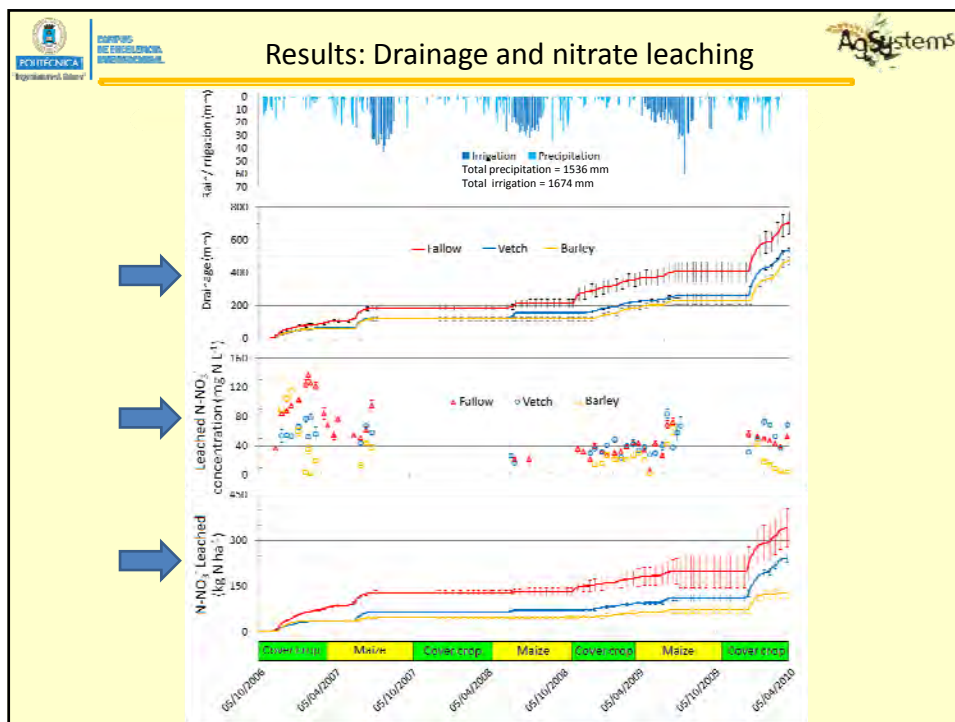
Year	Treatment	Biomass (kg ms ha ⁻¹)		N Concentration (%)		N Content (kg N ha ⁻¹)		
		Grain	Above ground	Grain	Above ground	Grain	Biomass	Above ground
2007	Vetch	12546	24129	1.16	0.49	168.7	44.8	213.5
	Barley	12922	25243	1.20	0.40	179.0	40.1	219.1
	Fallow	12351	24646	1.22	0.48	175.1	47.8	222.9
2008	Vetch	11590	22195	1.36	0.66	157.3	66.3	223.6
	Barley	11708	21805	1.30	0.61	151.4	58.2	209.6
	Fallow	11438	22281	1.30	0.61	147.3	61.4	208.8
2009	Vetch	11831	22477	1.35	0.72	158.7 a	71.2	230.0 a
	Barley	9796	18792	1.35	0.75	129.0 ab	63.2	192.2 ab
	Fallow	8446	17115	1.35	0.8	110.3 b	62.2	172.5 b

15










Conclusiones


- Reemplazar el barbecho por cultivos cubierta durante el periodo intercultivo del maíz en un sistema intensivo de regadío redujo la lixiviación de nitratos sin reducir la producción de maíz. En las parcelas con veza, se observó un aumento de la disponibilidad de N tras el segundo año.
- El NRF no se vio afectado por los CC y fue de 46% de media. Sin embargo, en los tratamientos con CC las pérdidas de N fueron menores en los años lluviosos, en los que el N fue retenido en el suelo. El contenido de ¹⁵N del suelo fue mayor en la veza, sugiriendo que fue retenido en fracciones más estables del horizonte superficial.
- EL mayor efecto de los CC en el control de la lixiviación de nitratos apareció durante el periodo intercultivo los años húmedos. Los años secos, cuando el nitrato se acumula en el suelo durante el invierno, el papel de los CC controlando la lixiviación de nitratos fue también relevante durante los estadios iniciales del maíz.
- Los CC aumentaron el reciclaje de N en el sistema y la disponibilidad de N el horizonte superficial. La cebada fue más eficiente controlando la lixiviación de nitratos. La veza favoreció la retención y disponibilidad de N en horizontes superficiales, reduciendo la lixiviación de nitratos respecto al barbecho.

European Journal of Agronomy. 2011. 34: 133-143
Agriculture Ecosystems & Environment. 2012. In press





UNIVERSIDAD DE ZARAGOZA
INSTITUTO DE INVESTIGACIONES AGROPECUARIAS



Índice presentación

- Empleo de cultivos cubierta en sistemas de regadío

➔ **Proyecto NTOOLBOX:**

- Catálogo de estrategias para control de la lixiviación de nitratos
- NDICEA: Modelo de simulación del balance de N en sistemas de cultivo

Toolbox of cost-effective strategies for on-farm reductions in N losses to water (N-Toolbox)

Objetivo general

Desarrollo de un conjunto de herramientas tecnológicas que faciliten la implementación de las estrategias para reducir las pérdidas de nitrógeno al agua desde los sistemas agrarios.




Participantes

Newcastle University (RU) Coordinador
 Louis Bolk Institute- Wageningen University (Países Bajos)
 University of Aarhus (Dinamarca)
 Universidad Politécnica de Madrid

Sistemas agrarios

1. Granjas de producción de leche. Reino Unido.
2. Sistemas integrados de hortalizas y cereales. Dinamarca.
3. Sistemas de producción hortícola en suelos arenosos. Países Bajos.
4. Sistemas de regadío basados en producción de cereal. Zona centro de España.

<http://research.ncl.ac.uk/nefg/ntoolbox/>

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N-TOOLBOX project:

Summary of strategies to reduce N losses to water from agricultural systems

Find the best strategies for your system: **Interactive Catalogue**

On-farm case studies:

Eden Valley, Northwest England

NVZs in Central Spain

Vegetable farms in The Netherlands


Vegetable farms in Denmark

The N-TOOLBOX project began in 2009 in response to a call from the EU for a project that would improve uptake of the **Nitrates Directive** at the farm level across the EU. The project brings together partners in the UK, The Netherlands, Denmark and Spain. The emphasis is on the identification and testing of practical solutions to the problem of nitrate pollution within the agricultural sector.

Now entering its final year, results are being compiled with the goal of coming up with some useful recommendations on how to improve farmer uptake of strategies to reduce water pollution. Recent results include:


- A catalogue of farm-level strategies to reduce N losses to water from agriculture has recently been completed and is available in **PDF format**, and as an **interactive web-based tool**
- Findings from on-farm case studies conducted by project partners in each country are available on this website
- The N management decision support tool, **NDICEA** has been improved during this project so that it is now adapted for use in the four partner countries, with an interface in Spanish, Dutch, Danish or English

Explore these web pages to find out more about this project and for links to other useful information about nitrogen management on farms in the EU.



The project (N-TOOLBOX-227156) is co-funded by the European Commission, Directorate General for Research, within the 7th Framework Programme of RTD, Cooperation Theme 2 - Biotechnology, Agriculture & Food.

The views and opinions expressed in this website are purely those of the writers and may not in any circumstances be regarded as stating an official position of the European Commission.







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Resumen de las estrategias para reducir las pérdidas de N al agua desde los sistemas agrarios


El proyecto NTOOLBOX se inició en 2009, financiado por la Unión Europea, para identificar estrategias agrarias a nivel de finca que permitan reducir las pérdidas de N al agua. En el proyecto se han producido una serie de documentos que describen el estado de conocimiento científico y aplicado de la implementación de estrategias para reducir las pérdidas de N (NLRS, en sus siglas en inglés) a nivel de finca. Si explora esta WEB encontrará muchos de estos documentos en formato pdf y convertidos en páginas WEB. En esta página, proporcionamos un resumen de las estrategias identificadas.


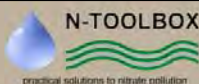

Las NLRS han sido divididas en 8 categorías. Haga clic en el enlace resaltado para ampliar información sobre las estrategias identificadas para cada categoría:

1. Almacenaje y tratamiento de residuos orgánicos
2. Manejo de ganado
3. Manejo de pastos para reducir pérdidas de N
4. Aplicación de dosis ajustadas
5. Mejores prácticas de manejo (RMP) de residuos orgánicos en suelos
6. Estrategias para regadíos
7. Ciclo eficiente de N a nivel de campo
8. Manejo de la escorrentía, drenaje y aguas residuales

1. Almacenaje y tratamiento de residuos orgánicos

En cualquier explotación ganadera en la que los animales están estabulados durante un período (excluye sistemas extensivos basados en pastoreo) los residuos orgánicos necesitan ser recogidos y almacenados antes de ser aplicados en tierras de cultivo. Surgen problemas cuando la capacidad de almacenaje para los residuos es insuficiente y los granjeros se ven obligados a aplicar los residuos en épocas no adecuadas. Este problema es especialmente relevante en las regiones del norte en las que hay un riesgo de contaminación cuando se aplican estiércoles durante el invierno en terrenos helados y/o en los que no hay un crecimiento activo de los cultivos. Por esta razón, el aumento de la capacidad de almacenaje es recomendable. El compostaje de residuos o emplear camas de establo con alto contenido de C, como la paja, puede ayudar a conservar N favoreciendo la conversión de N disponible en formas más estables de N orgánico. El riesgo de contaminación de cursos de agua con la escorrentía de las pilas de estiércol puede ser reducido colocando las pilas en lugares alejados de cursos de agua o sistemas de drenaje. Cubrir las zonas de almacenaje de estiércoles reduce la escorrentía, reduciendo por



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Toolbox of cost-effective strategies for on-farm reductions in N losses to water
N-TOOLBOX KBBE-2008-1-2-08

Innovative and cost-effective technologies to reduce N losses to water from agriculture in the EU: a catalogue of farm level strategies



Date: October 2011

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How to use it?

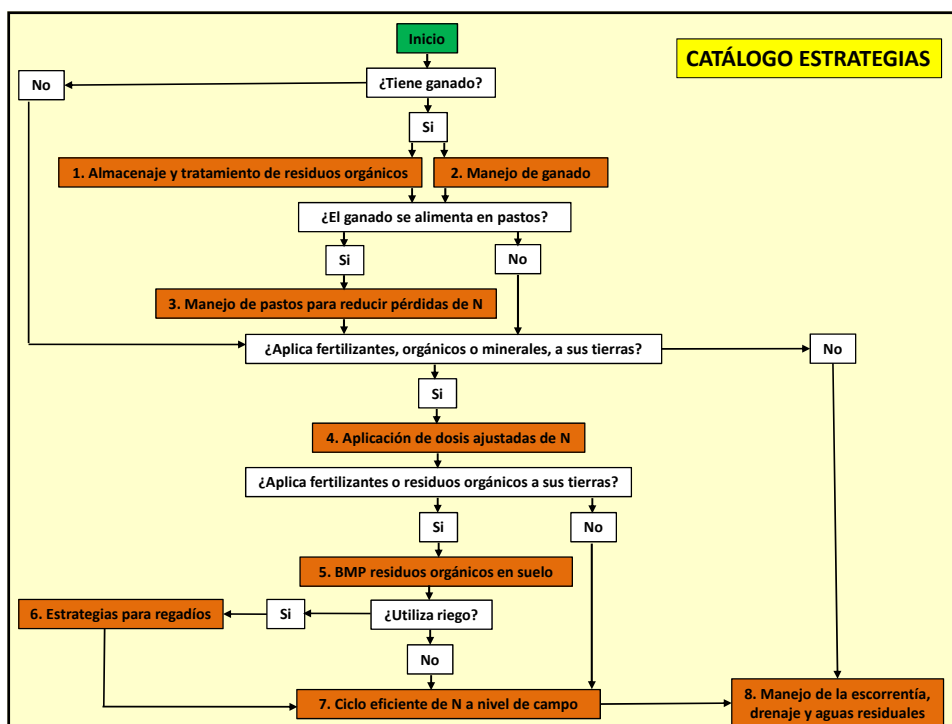
1 2 3 4 5 6 7 8 F

How to use the catalogue on-line

Strategies within this catalogue have been organized into 8 categories. By answering the questions, an appropriate subset of strategies will be identified for your specific situation. Within a category the strategies have been ranked as:

- Win-win strategies: known to reduce N losses to water at minimal cost to the farmer, and also expected to result in an improved net margin for the farmer
- Low-cost strategies: will reduce N losses to water and have a small cost, so they may reduce net margins slightly
- High-cost strategies: will reduce N losses to water but will require some investment by the farmer, so they will reduce net margins. These options are not likely to be adopted unless there is some compensation available to the farmer

« PREVIOUS BEGIN »



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Livestock management

Livestock management

Nitrogen can arrive on livestock farms in several forms (feed, fertilizer, imported animals, imported manure, N fixation) and can also leave by many pathways (exported products, losses to the atmosphere, losses to water from manure in the barn or in the fields). This makes management of N on livestock farms challenging. The strategies listed for this category are knowledge-intensive, rather than capital intensive. This means that they should be relatively inexpensive to implement, and that annual costs should steadily decline as the on-farm management expertise grows.

- 1. Decrease number of young cattle and reduce cattle turnover rate on dairy farms**

In general, farms with a lower stocking rate will have a lower N surplus; however, the challenge is to lower stocking rates without reducing productivity. This can be achieved if the cattle turnover rate is reduced, and cattle stay on the farm longer. [Learn more](#)
- 2. Reduce dietary N**

Supply feed that contains less N (e.g. by reducing the crude protein content of the feed). [Learn more](#)
- 3. Phase feeding**

Provide diets that are nutritionally optimized for a specific growth or reproductive stage or, in the case of dairy cattle, lactation cycle. [Learn more](#)
- 4. Balance dietary nitrogen and carbohydrates to optimize rumen function**

Excess nitrogen, especially in the form of rumen degradable protein and non-protein nitrogen, can increase ammonia levels in the rumen and lead to excessive levels of N excretion in urine. Supplying balanced amounts and types of protein and carbohydrates, can minimize rumen ammonia levels and optimize rumen function. [Learn more](#)

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Catalogue On-Line

Irrigation strategies

Do you use Irrigation?

NO

Strategies for irrigated land

The prevention of N losses to water in irrigated systems is closely linked to the management of irrigation water. Excessive applications of water can lead to the leaching of nitrates down below the root zone where they become groundwater pollutants. Even when water management is optimum, nitrate leaching can occur in the winter if rainfall is high and there is residual nitrate in the upper soil horizons.

- 1. Adjust the quantity of water applied to match crop needs**

Water supplied through irrigation should be optimized to avoid decreased yields or increased drainage. This can be accomplished through using proper irrigation scheduling according to crop evapotranspiration and by applying irrigation water in smaller amounts more frequently (e.g. split applications of irrigation water to more closely coincide with crop needs). The installation of flow meters is also essential so that amounts of water supplied can be properly monitored. [Learn more](#)
- 2. Fertigation**

Supply crop nutrients directly with the irrigation water, rather than applied to the soil. [Learn more](#)
- 3. Install more water use efficient irrigation systems**

Install more water use efficient irrigation systems. [Learn more](#)

[PREVIOUS](#)
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Efficient N cycling


Efficient N cycling at the field level

Closely linked to balanced N application rates are strategies to ensure the most efficient use and cycling of N in the field. Even when N applications have been calculated to closely match crop needs, there is still some risk of N losses to water after the fertilizer or manure-N has been applied in the field.


- 

1. Split fertilizer / manure applications
The required amount of fertilizer/manure is applied in several doses to more closely coincide with periods of crop demand. [\[Learn more...\]](#)
- 

2. Cultivate land for crop establishment in spring rather than autumn
In arable systems: Cultivate arable land for spring crops in the spring instead of in the autumn.
In ley/grassland systems: Plough out the grassland in the spring instead of in the autumn. [\[Learn more...\]](#)
- 

3. Use a catch crop
Catch crops are cover crops grown to catch available N in the soil and thereby prevent N leaching losses. They are usually planted after harvest of the main, commercial crop and left to grow during the non-growing season instead of leaving the land fallow. [\[Learn more...\]](#)
- 

4. Incorporation of high C:N ratio residues to promote immobilization of mineral N
Straw or other high C:N ratio residues are incorporated into the soil after crop harvest to act as a "sponge" that holds inorganic N in the soil during the season when no crop growth is occurring. [\[Learn more...\]](#)



3. Use a catch crop
Catch crops are cover crops grown to catch available N in the soil and thereby prevent N leaching losses. They are usually planted after harvest of the main, commercial crop and left to grow during the non-growing season instead of leaving the land fallow.

[hide this content](#)

How it works
By covering the land with a growing crop, nitrogen can be taken up instead of being lost through leaching during rainfall events. The crop will not only take up nitrogen but also water, reducing the amount of drainage occurring and hence reducing the amount of potential N leaching. The cover crop increases the retention of surplus inorganic N left in the soil after harvest of the main crop as well as capturing N released through on-going mineralization. In this way it can potentially reduce overwinter N leaching.

Regions and systems of applicability
Applicable in regions where there is a high amount of rainfall during the non-growing season i.e. where the main drainage occurs during the non-growing season. Especially applicable in temperate regions with mild winters as this will entail a high winter N mineralization and a longer growing season. It is also applicable in regions where irrigation is used during the dry months of the year, as this can result in an accumulation of inorganic N that is susceptible to leaching during the winter.

Cost
This strategy will require more labour during the non-growing season, equipment and fuel for seedbed establishment, and seed costs, as well as increased management time hence there will be on-going costs.
We have estimated that net margins per hectare can be increased by up to 180 €/ha in irrigated maize systems in Spain, depending on the type of catch crop planted when there is also a market for the harvested catch crop. If the catch crop is not harvested for sale, net margins will be lower and may at times result in a net loss, due to the added cost of seed and establishment.

Effectiveness
There have been numerous studies which have documented varying degrees of reductions in over-winter N leaching when catch crops are grown. This will depend on levels of residual N after crop harvest, over-winter temperatures and rainfall, and the growth and vigour of the catch crop. As an example we have estimated that in irrigated systems of maize production in Spain, nitrate leaching could be reduced by as much as 111 kg N/ha if a barley crop is grown during the winter months. Other studies have shown that winter cover crops can reduce nitrate leaching by 40-70% compared to bare fallow.

Other considerations
The incorporation of the catch crop may lead to a proportion of the captured N being lost due to rapid mineralization of green plant material, especially if some time elapses between incorporation and planting of the following crop. It is important to time catch crop incorporation to occur as closely as possible to the planting of the subsequent crop.
N leaching may increase in the long term (after approximately 10 years) in systems which continuously use catch crops, if fertilizer N is not reduced or the crop rotation is not changed. Therefore, catch crops should always be used in conjunction with balanced N application rates i.e. using an optimum N rate that includes an accurate estimate of soil N supply.
In the short term, yields of crops grown after catch crops can potentially decrease, especially if a legume catch crop is relied on as the sole source of N for the subsequent crop. This problem is worse if the C:N ratio of the catch crop is relatively high, resulting in immobilization of soil mineral N. In the first years artificial fertilization might be needed; however, in the long-term catch crops may benefit subsequent crops through soil organic N accumulation.

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Water management

Runoff, drainage and wastewater management

Runoff, drainage and wastewater management strategies can be called 'end of pipe' solutions to the problem of nitrate pollution. When all the strategies already listed in this catalogue are in place, there is still some risk of N pollution of water from agricultural activities. This is especially the case in areas where there are periods of intense, heavy rainfall which can result in large volumes of dirty water running off farmyards and fields.

- 1. Yardworks for clean and dirty water separation**
Upgrading of existing farmyard drainage water collection systems, to allow the separation of clean water and dirty water. [\[Learn more...\]](#)
- 2. Sedimentation ponds for treatment of surface runoff from fields**
Shallow ponds are constructed in low-lying areas of fields to intercept, store, slow and filter runoff during storm events³. [\[Learn more...\]](#)
- 3. Artificial wetlands for dirty water treatment**
Artificial, constructed wetlands physically filter dirty water and use biological processes (plant uptake, denitrification) to remove nutrients from wastewater from farmyards, milk house cleaning, and silage effluent. They may also be used to treat water that has been separated from slurry. They may include wetlands with surface (overland) flow or subsurface (percolation) flow. [\[Learn more...\]](#)
- 4. Riparian buffer strips**
Establish a vegetated strip adjacent to streams and wetlands. [\[Learn more...\]](#)

Newcastle University

N-TOOLBOX

practical solutions to nitrate pollution

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Catalogue On-Line

Catalogue summary

Thank you!




Contributors

The following people have contributed to the development of this catalogue of farm-level strategies to reduce N losses to water from agriculture:

- Julia Cooper, Elizabeth Stockdale, Majimcha Nobel de Lange, Andrew Carmichael, Kate Gascoyne - [Newcastle University](#)
- Geert-Jan van der Burgt, Bart Timmermans, Johannes Scholberg - [Louis Bolk Institute](#)
- Kristian Thorup-Kristensen, Hanne Kristensen - [Aarhus University](#)
- Miguel Quemada, Alberto Garrido, Antonio Vallejo - [Technical University of Madrid](#)

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<http://www.ndicea.nl>



NDICEA stikstofplanner

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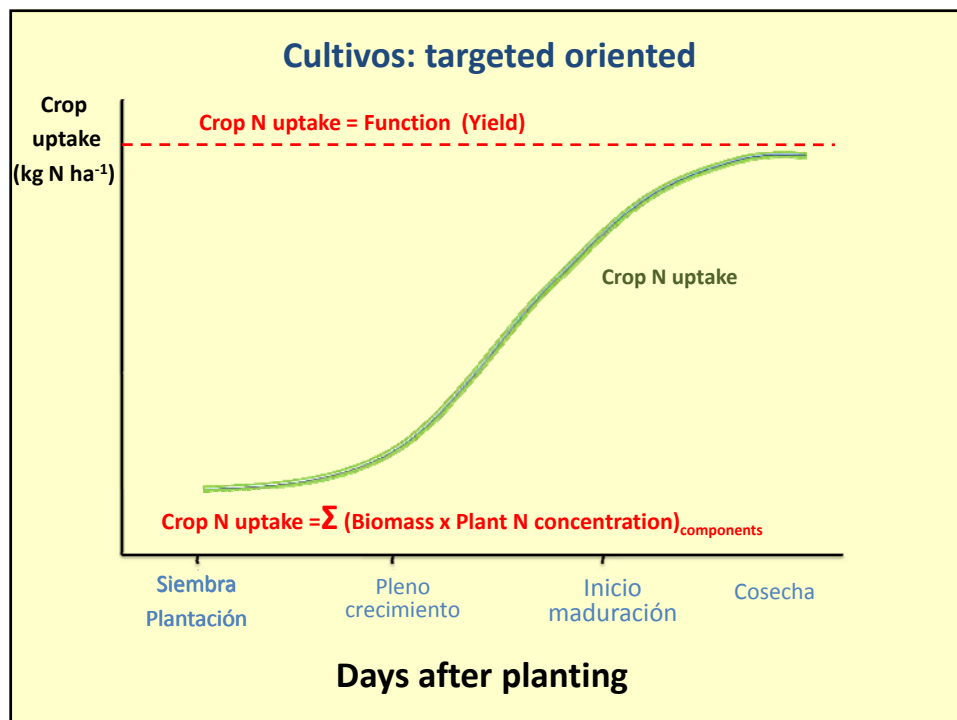
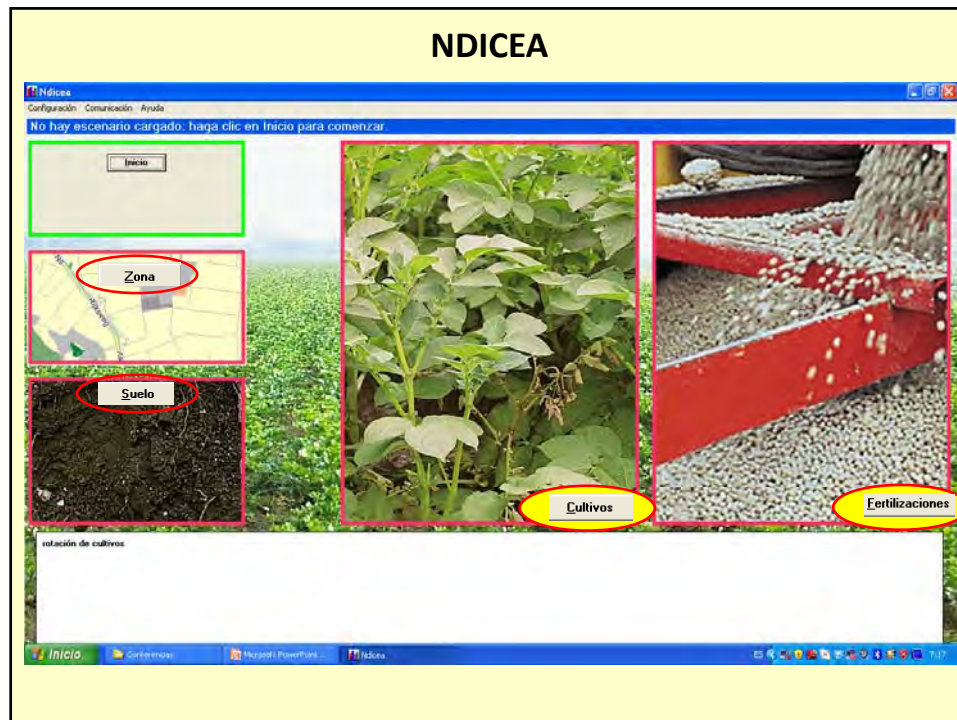
NDICEA
stikstofplanner

Hoe beheer ik stikstof op mijn bedrijf?

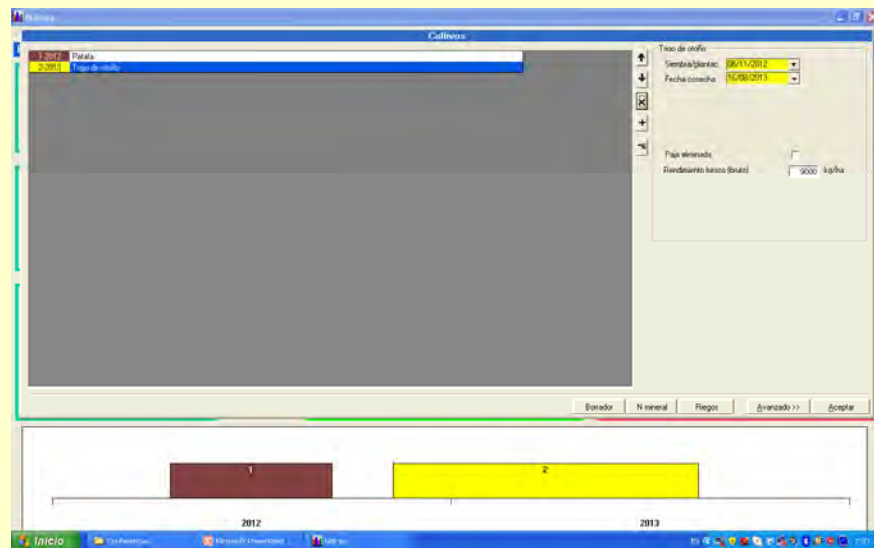
How to manage nitrogen on my farm?

¿Cómo manejar el nitrógeno en mi explotación?

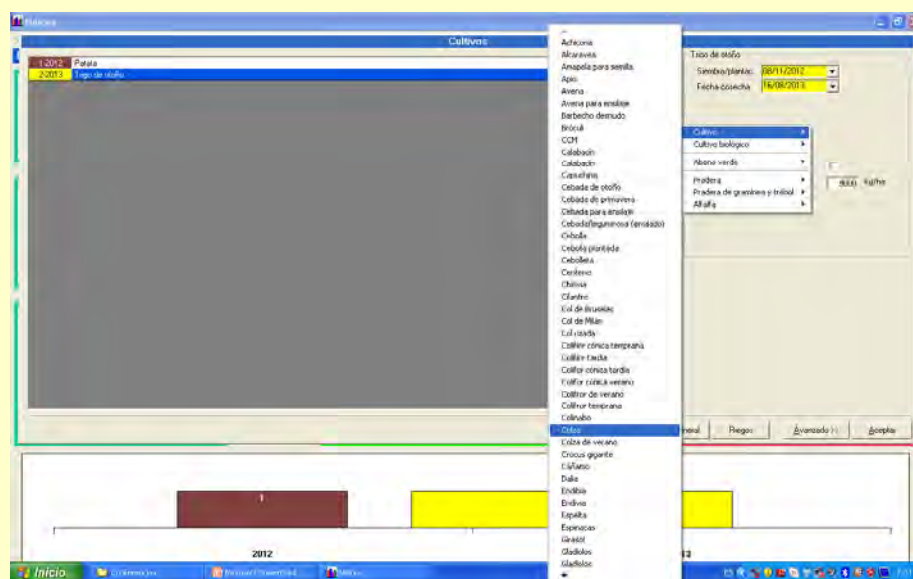
LOUIS BOLK
INSTITUUT



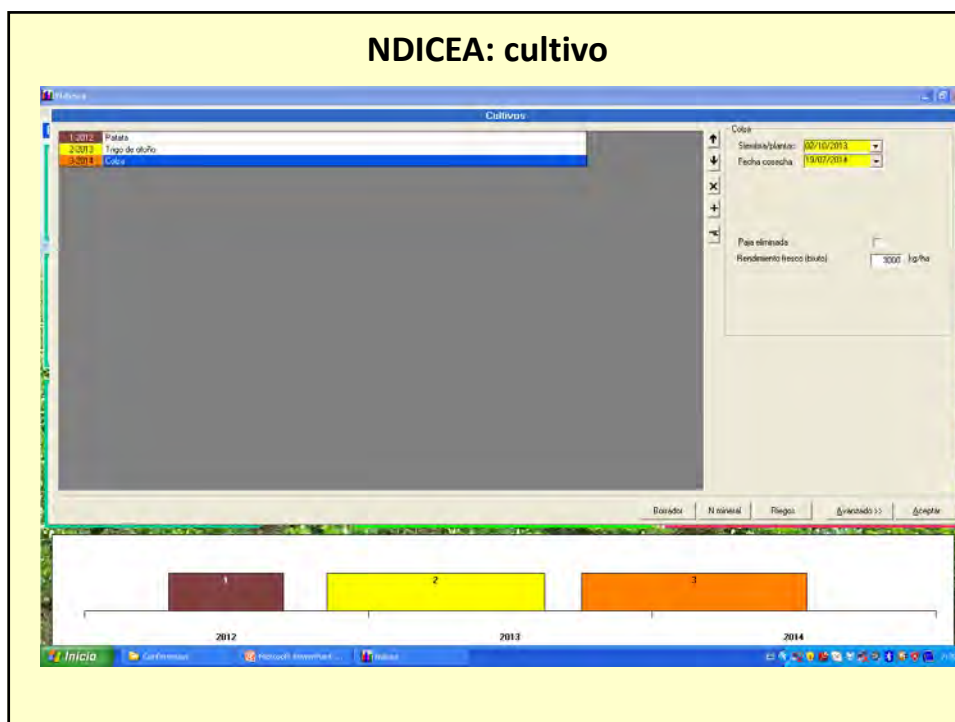
NDICEA: cultivo



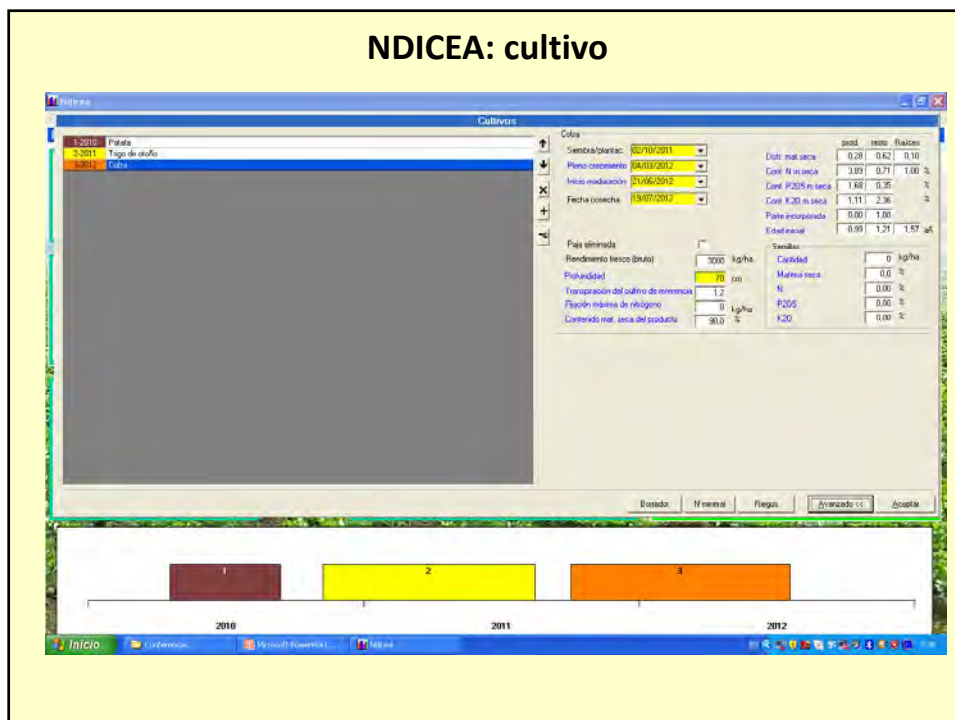
NDICEA: cultivo



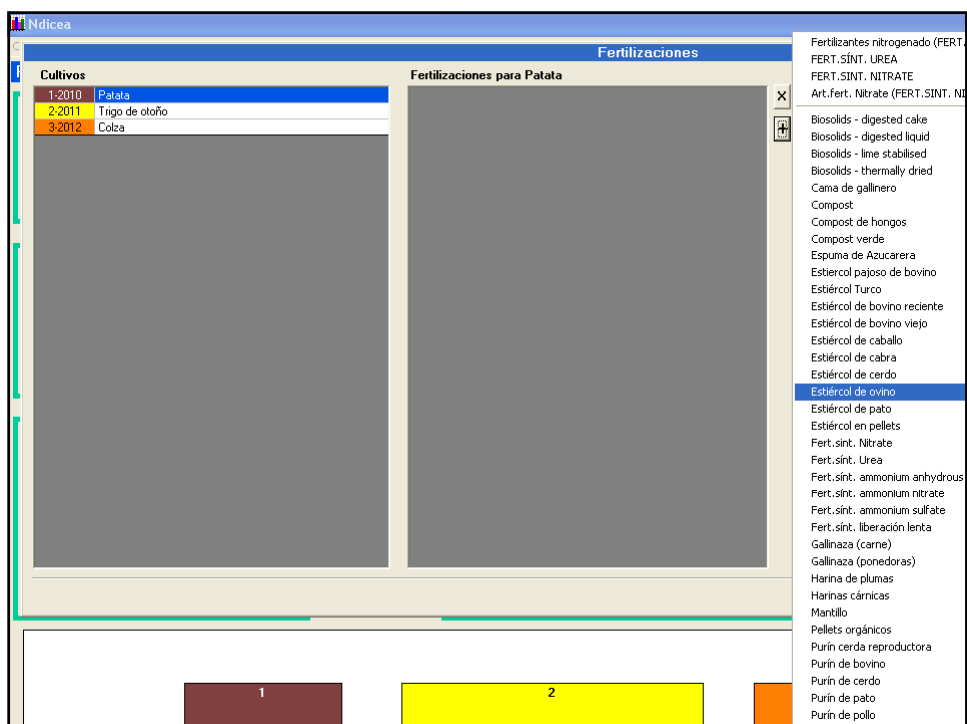
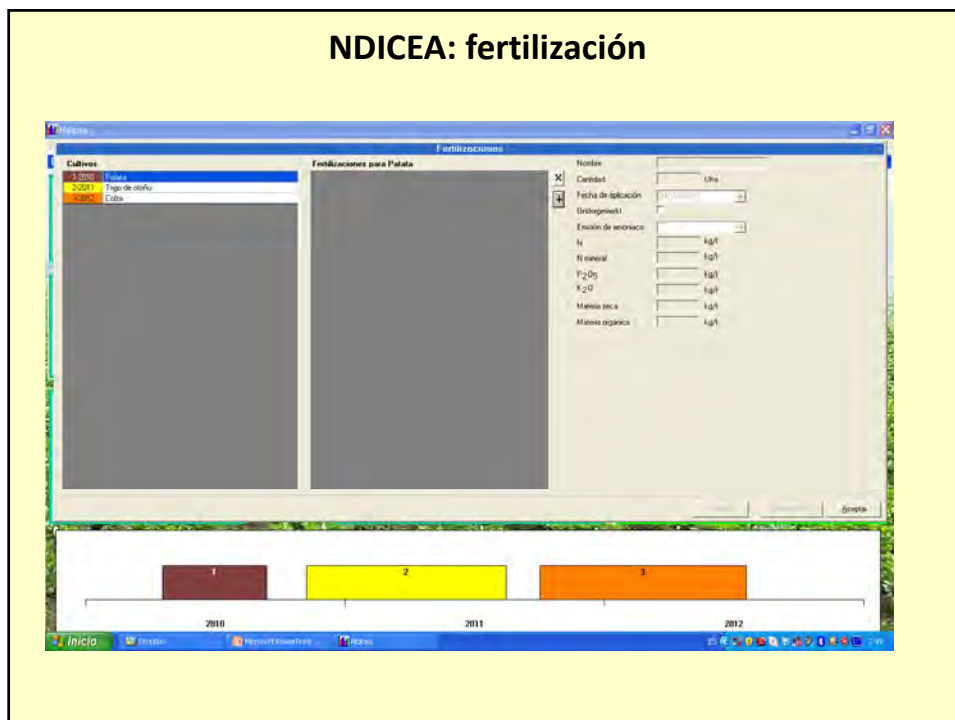
NDICEA: cultivo



NDICEA: cultivo



NDICEA: fertilización



NDICEA: fertilizantes

The screenshot shows the 'Fertilizaciones' window in the NDICEA software. The 'Cultivos' list on the left includes 'Palata' for the years 2010, 2011, and 2012. The 'Fertilizaciones para Palata' list on the right shows 'Enteol de orino' for 2010. The right-hand form contains the following data:

Nombre	Enteol de orino
Cantidad	10.0 kg/ha
Fecha de aplicación	13/04/2010
Enteol de orino	Luzimento reducida
N	8.6 kg/ha
N mineral	2.0 kg/ha
P ₂ O ₅	4.2 kg/ha
K ₂ O	16.0 kg/ha
Materia seca	250.0 kg/ha
Materia orgánica	205.0 kg/ha

At the bottom, a timeline shows three bars labeled 1, 2, and 3, corresponding to the years 2010, 2011, and 2012 respectively. Bar 1 is dark red, bar 2 is yellow, and bar 3 is orange.

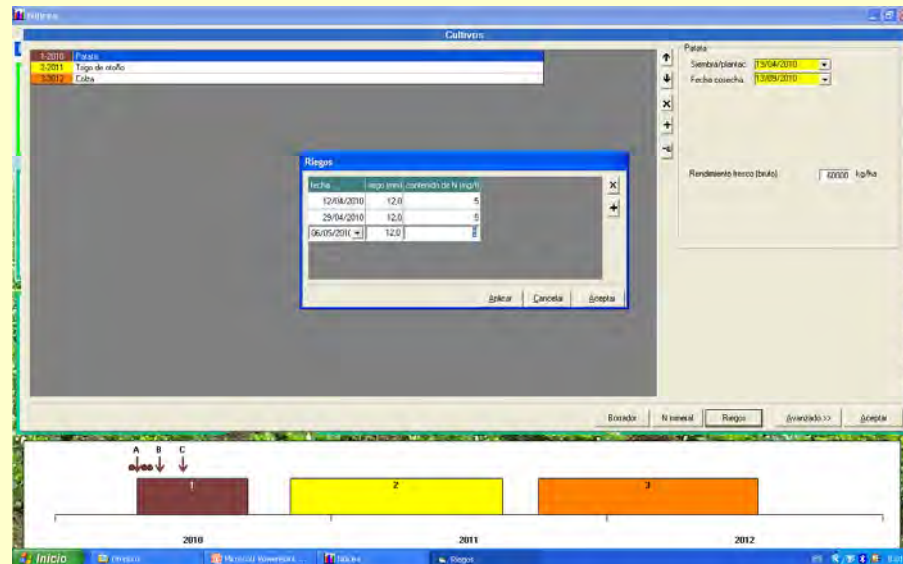
NDICEA: fertilizantes

This screenshot shows the same 'Fertilizaciones' window, but with a different fertilizer selected. The 'Fertilizaciones para Palata' list now includes 'Enteol de orino', 'Enteol de orino', and 'Enteol de orino'. The right-hand form contains the following data:

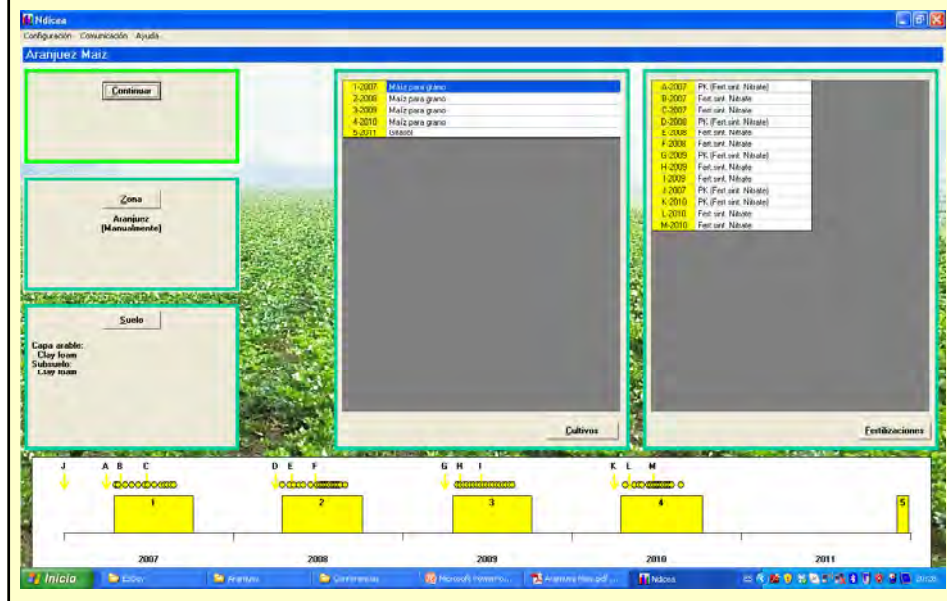
Nombre	Enteol de orino
Cantidad	10.0 kg/ha
Fecha de aplicación	13/04/2010
Enteol de orino	Luzimento reducida
N	8.6 kg/ha
P ₂ O ₅	4.2 kg/ha
K ₂ O	16.0 kg/ha

The timeline at the bottom remains the same, with three bars labeled 1, 2, and 3 for the years 2010, 2011, and 2012.

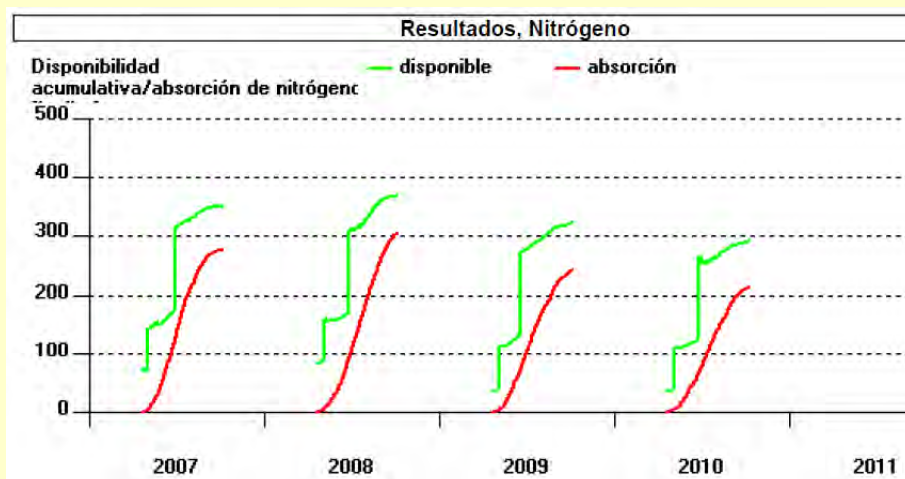
NDICEA: riegos



NDICEA: Aranjuez Maíz-Barbecho



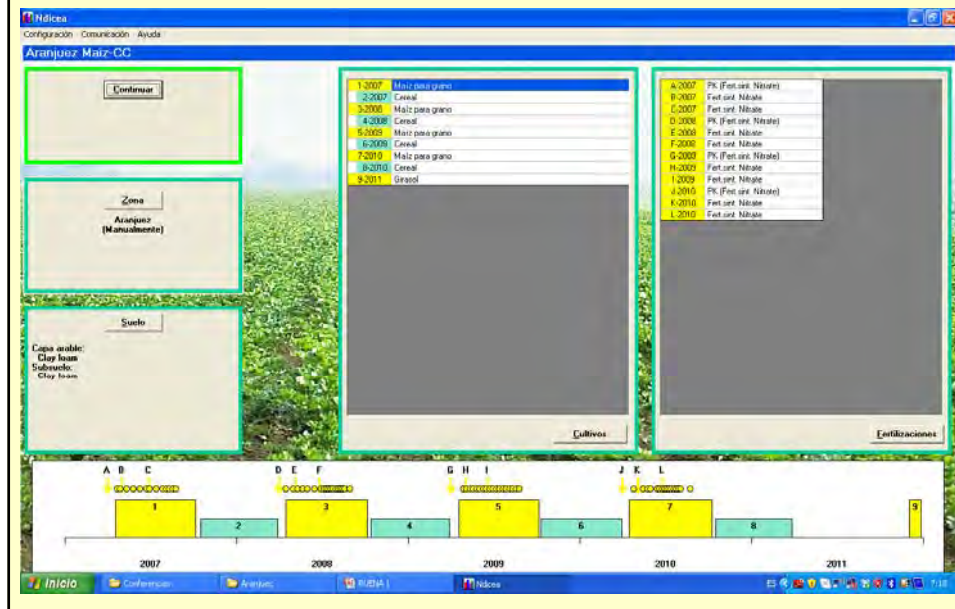
NDICEA: Aranjuez Maíz-Barbecho



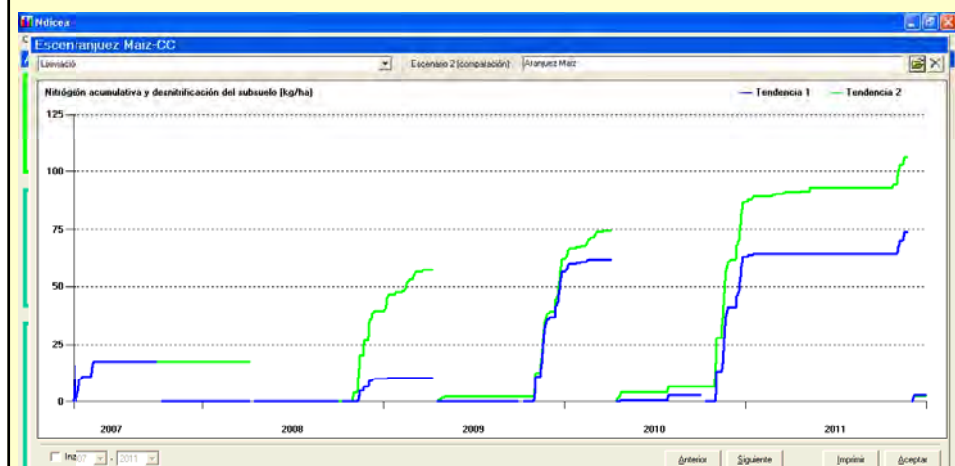
NDICEA: Aranjuez Maíz-Barbecho

Resultados, Balance mineral			
	N	P ₂ O ₅	K ₂ O
Suministro por fertilizantes	184	90	30
Fijación de nitrógeno	0		
Deposición	5	3	8
Suministro total	189	93	38
Extracción por los productos	146	82	54
Excedente calculado	43	12	-16
Emisión	0		
desnitrificación	21		
lixiviación	68		
Acumulación de materia orgánica	-22,6		

NDICEA: Aranjuez Maíz-CC

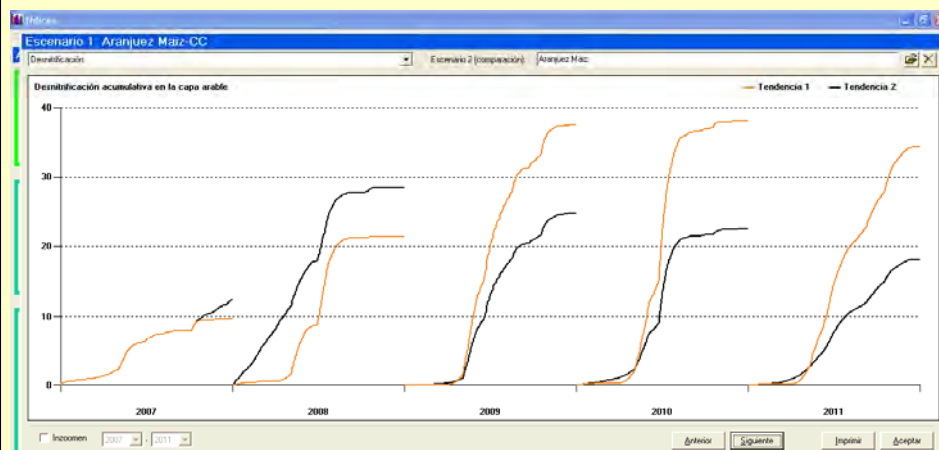


NDICEA: Aranjuez Maíz (línea verde) vs. Maíz-CC (línea azul)



NDICEA: Aranjuez

Maíz (línea negra) vs. Maíz-CC (línea marrón)



NDICEA: Aranjuez

Maíz-CC (Escenario 1) vs. Maíz (Escenario 2)

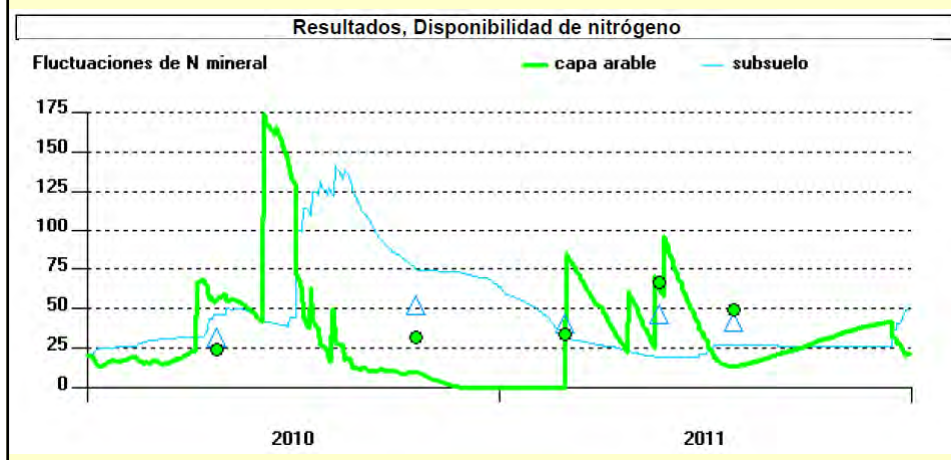
Escenario 1: Aranjuez Maíz-CC						
Escenario 1			Escenario 2			
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
[Todo en kg/ha]						
Suministro por abono	184	90	30	184	90	30
Fijación de nitrógeno	0			0		
Deposición	5 +	3 +	8 +	5 +	3 +	8 +
Suministro total	189	93	38	189	93	38
Extracción por productos	146 -	82 -	54 -	146 -	82 -	54 -
Excedente calculado	43	12	-16	43	12	-16
Volatilización	0			0		
Desnitrificación	28			21		
Lixiviación / desnitr. subsuelo	50			68		
N en acumulación de mat. org.	1			-23		

NDICEA: aplicación

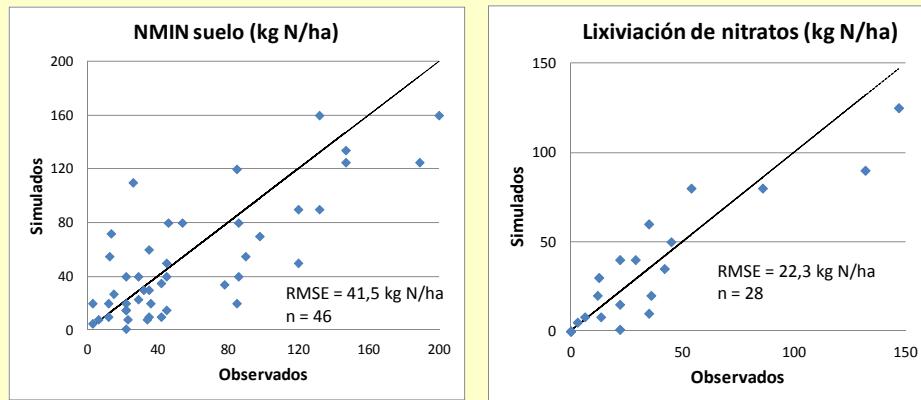
- Aranjuez: La Chimenea
Maíz vs. Maíz- CC (4 años)
- Albacete: Las Tiesas (ITAP)
Maíz- Trigo (2 años)
- Albacete: La Candelaria (ITAP-agricultor)
Maíz- Trigo (2 años)

NDICEA: aplicación

- Albacete: La Candelaria (ITAP)
Maíz- Trigo (2 años)



NDICEA



NDICEA: Fundamentos

- Paso temporal: 1 día
- Minimizar no. ecuaciones y parámetros
- Evapotranspiración: Adaptación FAO no. 56 (Allen et al. 1998)
- Movimiento agua en el suelo: modelo pistón con coeficiente retardo
- Mineralización MO: Modelo descomposición dos pools (Janssen 1996)
- Lixiviación nitratos: Producto agua percolada por debajo de raíces y concentración nitratos último horizonte (factor corrección)
- Desnitrificación: función desnitrificación potencial, contenido MO, disponibilidad nitratos, humedad (Bradbury et al., 1993)
- Volatilización amoniacal: Adaptación tablas USDA (Follet et al. 1991)
- Posibilidad calibración con datos medidos en campo

Burgt et al. Nutrient Cycling in Agroecosystems. 2006. 74: 275-294
 Página WEB: <http://www.ndice.nl>

NDICEA: ¿Para que NO sirve?

- **Recomendación del fertilizante a aplicar durante la campaña**
- **Toma de decisiones a tiempo real**

NDICEA: ¿Para que sirve?




- **Obtener balances representativos de nutrientes en sistemas de cultivo específicos**
- **Diseño y comparación de estrategias de manejo de nutrientes: toma decisiones a medio plazo**
- **Inicio y base de discusión con agricultores, técnicos o estudiantes**

¿Cómo obtenerlo?

Dirección: <http://www.ndicea.nl>

Gratuito

Registrarse



Índice presentación

- Empleo de cultivos cubierta en sistemas de regadío
- Proyecto NTOOLBOX:
 - **Catálogo de estrategias** para control de la lixiviación de nitratos
 - **NDICEA**: Modelo de simulación del balance de N en sistemas de cultivo

Gracias por vuestra atención

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